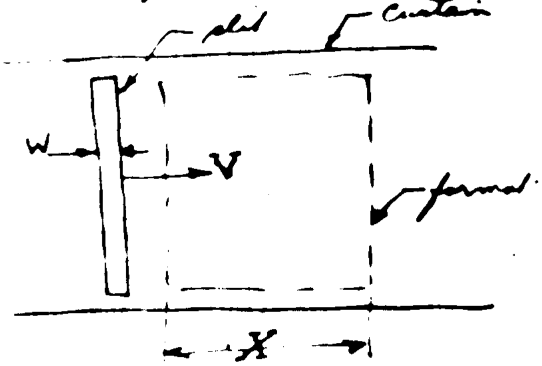
Dear Al —

The geometrical proof of the focal (rotary) shutter is outlined below. As I explained by phone the typical linear slit type curtain is similar (if not identical) to the rotary slit except for the fact that the slit is moving along an arc rather that straight line.

Compare:

1)



Linear Slit Arrangement.

The velocity (V) of curtain (inches/second) and slit width (w) in inches determine effective exposure. Slit has parallel edges – exposure will be uniform because velocity is the same for all parts of the length of slit. If w is increased to X (format size) the exposure is still uniform but exposure time is changed.

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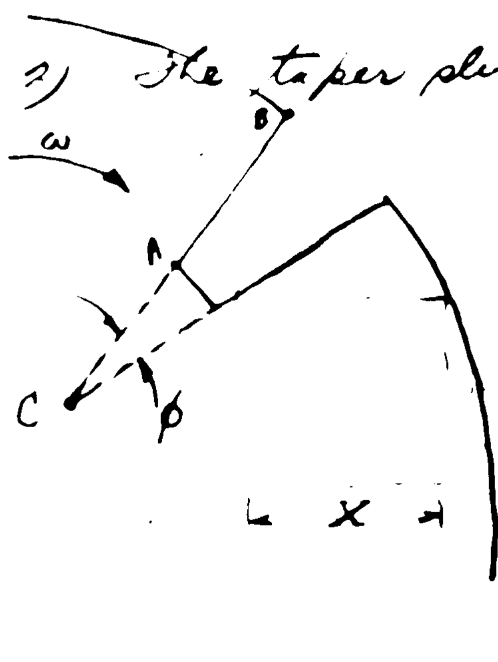
2) The taper slit now:



X is the format, C the center of rotation of the rotary shutter (angle φ is adjustable). Point A and B describe the radius for the inner & outer frame edges respectively. Assume radius $\overline{CA}$ equal to one-half

velocity of the blades assembly moves about point C. Effectively the line $\overline{CAB}$ moves circularly with one end fixed at C — OK! Further A and B move at different speeds past the format because they are at different distances from C. Now if B is twice as far from C as is A then B is moving twice as fast as A. This is perfectly compensated for by the fact that angle ϕ (shutter opening) is tapered in the proper direction

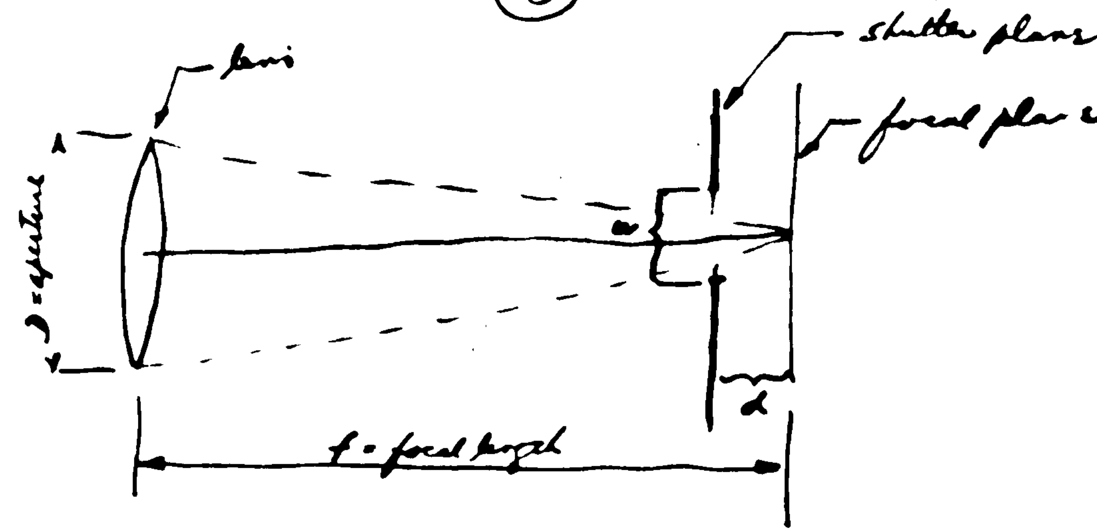
Because B is going faster than A, the slot is wider at B than at A by exactly 2 to 1 which compensates exactly for their different radial velocity.

Note: if the slot ϕ was parallel edged, then vignetting would result. Wedge shaped however it is fully compensating.

Exposure with rotary taper opening is uniform.

Efficiency:

This is a horse of a different genage and has no relationship to above. In our system the efficiency varies because of the wide variety of apertures and focal lengths. However the following will be of interest for proof.



Efficiency is calculated by the following relationships of items shown above:

$$E = \frac{W \times f}{W \times f + d \times D}$$

In our camera d is approx 3/16 (0.187") let take the short lens first. The 1" is F/2.3 and has a lens diameter of approx 0.580". The shutter width is adjustable and efficiency will vary accordingly but for our purpose let pick the tough end and assume 1/4" width OK? now —

$$E_{(\text{one inch})} = \frac{0.25 \times 1}{(.25 \times 1) + (.187 \times .580)} = 72\% \text{ approx.}$$

Note Our average opening will be about twice this anyway which means at worst the efficiency will average about 85% for our 1" lens. This is not bad at all.

Now the longest one — 24" in F/5.6 is about 4.5 inch lens diameter — so —

$$E_{(24\ \text{inch})} = \frac{0.25 \times 24}{(0.25 \times 24) + (.187 \times 4.5)} = 89\% \text{ approx}$$

Plus the (24" wide slit) is smaller than average — so I'd guess now that the overall average efficiency of the system will be about 85 - 90%. The average photo gear varies from 40 to 80% generally and we'll be right up there -

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